REMARKS

Reconsideration and allowance are respectfully requested in light of the above amendments and the following remarks.

To overcome the obviousness-type double patenting rejections, a terminal disclaimer is submitted herewith, to expedite issuance. However, it is noted that the claims are patentably distinct at least because the terms "obtaining" and "determining" refer respectively to decoding and coding of the motion-compensated image.

To overcome the objection to the continuation data, the specification is amended and a corrected double-column sheet is provided.

Claims 2 and 6-10 are hereby amended to clarify the claimed subject matter. For the convenience of the Office, marked up versions of the amended claims are attached. Support for the amended language is found in Fig. 5 and the discussion at original patent col. 8, line 62 *et seq.*

The Original Letters Patent No. 5,745,182 was surrendered on April 6, 2001.

A draft Reissue Declaration is attached for approval prior to execution. It is noted that both the Statement under 37 CFR 3.73(b) and the Assent of Assignee were filed and accepted in

parent reissue application no. 09/559,627, without objection to absence of a date. It is hereby noted that these documents were signed during the period of April 18-26, 2000. Copies thereof were filed in the present application. If new signed and dated documents are required, they will be submitted subsequently.

To expedite issuance, an executed Reissue Declaration, a re-executed Statement under 37 CFR 3.73(b) and a re-executed Assent of Assignee will be filed as soon as possible.

In light of the foregoing, a Notice of Allowance is respectfully solicited.

If any issues remain which may best be resolved through a telephone communication, the Examiner is requested to telephone the undersigned at the local Washington, D.C. telephone number listed below, in order to expedite consideration and allowance of this application.

Respectfully submitted,

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Marked Up Version of the Claims

2. (Amended) A method of determining motion compensation for an input image from a motion vector between the input image and a plurality of reference images, said method comprising the steps of:

(a) detecting a motion vector MV1 between the input image and one reference image R1 of said plurality of reference images at a second set time interval T_2;

Q1

(b) providing a motion vector MV3 between the reference image R1 and another reference image R2 of said plurality of reference images at a first set time interval T_1, said motion vector MV3 being parallel to the motion vector MV1 and different in magnitude from the motion vector MV1 by a value determined by $MV1 \cdot T_1 / T_2$;

(c) obtaining a motion vector MV2 between the input image and the another reference image R2 at a third set time interval T_3 from a ~~sum~~ combination of the motion vector MV1 and the motion vector MV3, and calculating respective ~~pixels~~ pixel values corresponding to the motion vector MV1 and the motion vector MV2 from pixels ~~of the reference image R1 and the reference image R2~~ at positions corresponding to the motion vector MV1 and the motion vector MV2 and/or from peripheral pixels ~~positioned peripherally of the pixels of the reference image R1 and the~~

~~reference image R2~~ at positions corresponding to the motion vector MV1 and the motion vector MV2; and

(d) calculating motion-compensated pixel values from the calculated ~~pixels of the reference images~~ respective pixel values.

a1

4. (Previously Presented) A method in accordance with claim 1, wherein said motion vector MV1 between the input image and said one reference image of said plurality of reference images is calculated from a motion of at least one block unit at said second set time interval, said at least one block unit being a part of said input image and comprising a plurality of pixels.

a2

5. (Previously Presented) A method in accordance with claim 2, wherein said motion vector MV1 between the input image and said one reference image of said plurality of reference images is calculated from a motion of at least one block unit at said second set time interval, said at least one block unit being a part of said input image and comprising a plurality of pixels.

6. (Amended) A method in accordance with claim 2, wherein step (c) comprises ~~obtaining said motion vector MV2 from a mean of said motion vector MV1 and said motion vector MV3, and said~~

~~pixels positioned peripherally are valued~~ calculating said respective pixel values in accordance with ~~an average weighting~~ a weighted average inversely proportional to distance from pixels of the reference image R1 and the reference image R2.

7. (Amended) A method of obtaining motion compensation for an input image, said method comprising the steps of:

(a) obtaining a first motion vector MV1 between the input image and one reference image R1 of a plurality of reference images at a second set time interval T2 between the input image and said one reference image R1;

(b) calculating a second motion vector MV2 between the input image and another reference image R2 of said plurality of reference images at a first set time interval T1 between the input image and said another reference image R2, said second motion vector MV2 being parallel to said first motion vector MV1 and having a magnitude satisfying the relation MV2=MV1·(T1/T2);

(c) calculating pixel values ~~of said one reference image R1 from pixels~~ at positions corresponding to said first motion vector MV1 from pixels of said one reference image R1 and calculating pixel values ~~of said another reference image R2 from pixels~~ at positions corresponding to said second motion vector MV2 from pixels of said another reference image R2, wherein said

reference images R1 and R2 are such that a motion vector MV3 between said reference images R1 and R2 has a mathematical relationship with said first and second motion vectors MV1 and MV2 in which said motion vector MV3 is parallel to and different in value from each of said first and second motion vectors MV1 and MV2; and

(d) calculating ~~said motion compensation of said input image~~ motion-compensated pixel values from ~~said pixel values~~ both said pixel values at positions corresponding to said first motion vector MV1 and said pixel values at positions corresponding to said second motion vector MV2 calculated in step (c) to obtain said motion compensation for said input image.

a2

8. (Amended) A method of obtaining motion compensation for an input image, said method comprising the steps of:

(a) obtaining a first motion vector MV1 between the input image and one reference image R1 of a plurality of reference images at a second set time interval T2 between the input image and said one reference image R1;

(b) calculating a second motion vector MV2 between the input image and another reference image R2 of said plurality of reference images at a first set time interval T1 between the input image and said another reference image R2, said second

motion vector MV2 being parallel to said first motion vector MV1 and having a magnitude satisfying the relation MV2=MV1·(T1/T2);

(c) calculating pixel values ~~of said one reference image R1 from pixels at positions~~ corresponding to said first motion vector MV1 from pixels of said one reference image R1 and calculating pixel values ~~of said another reference image R2 from pixels at positions~~ corresponding to said second motion vector MV2 from pixels of said another reference image R2, wherein said reference images R1 and R2 are previous to said input image in a time sequence; and

a2

(d) calculating ~~said motion compensation of said input image~~ motion-compensated pixel values from ~~said pixel values~~ both said pixel values corresponding to said first motion vector MV1 and said pixel values corresponding to said second motion vector MV2 calculated in step (c) to obtain said motion compensation for said input image.

9. (Amended) A method of obtaining motion compensation for an input image, said method comprising the steps of:

(a) obtaining a first motion vector MV1 between the input image and one reference image R1 of a plurality of reference images at a second set time interval T2 between the input image and said one reference image R1;

(b) calculating a second motion vector MV2 between the input image and another reference image R2 of said plurality of reference images at a first set time interval T1 between the input image and said another reference image R2, said second motion vector MV2 being parallel to said first motion vector MV1 and having a magnitude satisfying the relation MV2=MV1·(T1/T2);

(c) calculating first pixel values ~~of said one reference image R1~~ corresponding to said first motion vector MV1 from pixels of said one reference image R1 which are neighbors of a2 positions corresponding to said first motion vector MV1 and calculating second pixel values ~~of said another reference image R2~~ corresponding to said second motion vector MV2 from pixels of said another reference image R2 which are neighbors of positions corresponding to said second motion vector MV2, wherein said reference images R1 and R2 are such that a motion vector MV3 between said reference images R1 and R2 has a mathematical relationship with said first and second motion vectors MV1 and MV2 in which said motion vector MV3 is parallel to and different in value from each of said first and second motion vectors MV1 and MV2; and

(d) calculating ~~said motion compensation of said input image~~ motion-compensated pixel values from said first and second pixel

values calculated in step (c) to obtain said motion compensation for said input image.

10. (Amended) A method of obtaining motion compensation for an input image, said method comprising the steps of:

(a) obtaining a first motion vector MV1 between the input image and one reference image R1 of a plurality of reference images at a second set time interval T2 between the input image and said one reference image R1;

(b) calculating a second motion vector MV2 between the input image and another reference image R2 of said plurality of reference images at a first set time interval T1 between the input image and said another reference image R2, said second motion vector MV2 being parallel to said first motion vector MV1 and having a magnitude satisfying the relation MV2=MV1·(T1/T2);

(c) calculating first pixel values ~~of said one reference image R1~~ corresponding to said first motion vector MV1 from pixels of said one reference image R1 which are neighbors of positions corresponding to said first motion vector MV1 and calculating second pixel values ~~of said another reference image R2~~ from pixels of said another reference image R2 which are neighbors of positions corresponding to said second motion vector

MV2, wherein said reference images R1 and R2 are previous to said input image in a time sequence; and

(d) calculating ~~said motion compensation of said input image~~ motion-compensated pixel values from said first and second pixel values calculated in step (c) to obtain said motion compensation for said input image.

Q2

11. (Previously Presented) A method in accordance with claim 7, wherein said reference images R1 and R2 are previous to said input image in a time sequence.

12. (Previously Presented) A method in accordance with claim 9, wherein said reference images R1 and R2 are previous to said input image in a time sequence.

This is a reissue of U.S. Patent No. 5,745,182 which is a division of application Ser. No. 07/970,046 filed Nov. 2, 1992, now U.S. Pat. No. 5,369,449. This application is a continuation of reissue application no. 09/559, 627, filed April 27, 2000 and has the following co-pending related reissue applications: 09/833,680 filed April 13, 2001, 09/833,770 filed April 13, 2001 and 09/866,811 filed May 30, 2001.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for determining motion compensation of a moving image to be utilized in an apparatus which requires a prediction of a moving image such as an image transmission apparatus and an image apparatus.

2. Description of the Prior Art

With the progress of semiconductor technologies, methods for determining motion compensation to be utilized for a transmission of an image and a compression of an image have been widely used in many fields in recent years. Among such conventional methods for compensating for motion of a moving image, there is one method for compensating for motion of a moving image based on one piece of a reference image.

FIG. 6 is a diagram for showing the concept of the conventional method for compensating for motion of an image. Referring to FIG. 6, a moving image signal is a set of images which are sampled with an equal time interval tO on the time axis. For example, an NTSC signal has images sampled at every 1/60 second for each field and a PAL signal has images sampled at every 1/50 second for each field. When a certain object of which images are to be picked up is moving, for example, the spatial position of an object A in an M-th image is deviated from the spatial position of an object A' in an (M−1)-th image by a portion of a move of the object during a period of tO. Now, consider a case for predicting the M-th image from the (M−1)-th image. In order to make a determination of the M-th image with a high level of precision by compensating for motion of the object from an input image to a reference image during a time difference of tO, the M-th image is divided into blocks including at least one pixel, and a move of each block from the (M−1)-th image to the M-th image is detected so that a pixel value of the image at a position deviated by the portion of this move is set as a determined value. This will be explained with reference to FIG. 6. To obtain a determined value of a pixel X of the M-th image, a pixel X' at the same spatial position as the spatial position of the pixel X in the (M−1)-th image is deviated by a detected move MV of a block unit including the pixel X', so that a pixel X" is obtained. This pixel X" is then used as a determined value of the pixel X. In FIG. 6 the block is assumed to have a size of 3×3.

When a signal is an interlace sisal, there are many alternative cases considered for predicting compensation for motion of an image. For example, either a frame or a field is used for the image, and a frame is used for a reference image and a field is used for an input image, etc. The basic principle is as explained with reference to FIG. 6 above. As one of the examples of the above method for predicting motion compensation, there is Recommendation 723, "Transmission of component-coded digital television signals for contribution-quality at the third hierarchical level of CCITT Recommendation G.702" which was standardized by the CMTT (Commission Mixte CCIR/CCITT pour les Transmissions Televisuelles et Sonores 3). In this recommendation, a determination of motion compensation between frames and a determination of motion compensation between fields are suitably changed over between the two cases. As described above, according to the conventional method for determining motion compensation of an image, a determination is made by compensating for motion of the image based on detected motion of the image. Therefore, the conventional predicting method can predict motion compensation with a high level of precision even if an image is a moving image including movement.

The above-described conventional method for determining motion compensation, however, has problems that it is not possible to accurately determine motion compensation and that, even if it is possible to correctly determination of motion compensation, the image density of an image to be referred to becomes the image density of a reference image, which makes it impossible to make prediction at a higher level of precision.

For example, in the case of determining motion compensation by using an interlace signal as a frame and generating a block from this frame, frames are combined together to compensate motion of an image by disregarding a difference in sampling positions, due to a time difference, between two fields within a frame. Accordingly, when correct sampling positions of the fields are considered, there is such a case that motion compensated in the first field and motion compensated in the second field do not coincide with each other. An example of this case is shown in FIGS. 7A to 7C. Referring to FIGS. 7A to 7C, an input signal is an interlace signal (FIG. 7A). Interlace signals are combined together in a frame to determine motion compensation. When a vertical component of a motion detected now is 1, the first field of the M-th frame is predicted from the second field of the (M−1)-th frame and the second field of the M-th frame is predicted from the first field of the (M−1)-th frame, as shown in FIG. 7B. Moves in the correct field positions is shown in FIG. 7C. As is clear from FIG. 7C, the motion for effecting compensation in the first field of the M-th frame do not coincide with the moves for effecting compensation in the second field of the M-th frame. As explained above, when motion compensation of an image is made by handling an interlace image as a frame, the motion for effecting compensation are different between the first field and the second field. In a vector in which this phenomenon occurs, there is a problem that the precision of the level of prediction is deteriorated.

Next, consider a case of determining motion compensation of an image as an image of a correct position without disregarding a time difference of sampling between images as described above. As examples of this case, there is a case where motion compensation is determined for an interlace signal by generating a block from a field, and a case where motion compensation is determined for a noninterlace signal. In the above cases, motion compensation is predicted by using an image at a position of a correct time. Therefore, there arises no such problem which occurs in the case of determined motion compensation by generating a block from a frame of the interlace signal as described above. However, in this case, motion compensation is determined from one piece of reference image and the pixel density of an image to be referred to becomes the pixel density of the reference image, so that there is a limit to carrying out a determination of motion compensation at a higher level of precision. FIG. 8 shows a case of determined move compensation by generating a block from a field for an input of an interlace signal. In this case, determination of motion compensation is carried out by using a field image as a reference image. Therefore, when a motion vector is O there is no sampling point at a position necessary for making a determination on the reference image and, accordingly, a